

## RAIRS Investigation of Co-Adsorption of CO and C<sub>2</sub>H<sub>4</sub> on Cu(110)

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Beamline(s): U4IR

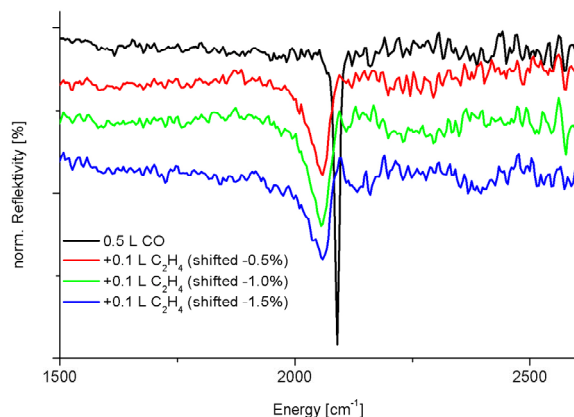
**Introduction:** The spectroscopically observable behaviour of CO and C<sub>2</sub>H<sub>4</sub> adsorbed on Cu single crystals and cold deposited films shows varied dependence on the orientation of the Surface structure and the sequence of gas dosing.

**Methods and Materials:** In the experimental study we used the RAIRS-Setup to observe the adsorption of Ethylene and CO on Cu(110) single crystals and compared them (together with earlier acquired measurements at the same beamline using cold deposited Cu-films as substrate) to results of investigations of the same systems by other spectroscopic means (Raman scattering, SERS). For this study the Cu-sample was mounted with cooling and heating in a UHV-Vessel with a base pressure <2 10<sup>-10</sup> mbar and a IR-grazing incidence setup was used. For sample preparation we sputtered and annealed the sample repeatedly before checking the surface for contamination with an Auger-Spectrometer.

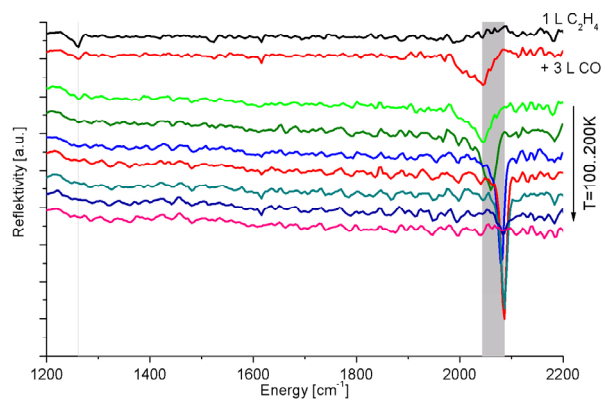
**Results:** Figure 1 shows the spectra of a co-adsorption experiment on Cu(110) with the observed CO-stretch mode. While this vibrational mode of pure CO on Cu has a narrow shape with peak energy at 2091 cm<sup>-1</sup> (black curve) it is considerable broadened and shifted to the energy of 2060 cm<sup>-1</sup> after dosing 0.1 L C<sub>2</sub>H<sub>4</sub> (red curve). However this process doesn't change the integrated peak area of the CO-mode and neither the shift nor the broadening is increased by further Ethylene dosing (green+blue curve). The same peak-shape and position of the CO-mode is also observable when firstly Ethylene is let in the vacuum chamber before CO is dosed. In both of these cases it is possible to shift the CO-peak back to 2091 cm<sup>-1</sup> and reverse the broadening of it by heating the Ethylene (which has a lower desorption temperature than CO) off the substrate before the CO itself is removed at sufficiently high temperature. This is shown in Figure 2.

**Conclusions:** This measurements in combination with results of other experiments mentioned above are part of a concept we developed of what happens during adsorption and co-adsorption of CO and C<sub>2</sub>H<sub>4</sub> on Cu single-crystals and rough surfaces. In this documented case the CO molecules are adsorbed on the Cu-crystal and stick in their places when C<sub>2</sub>H<sub>4</sub> is dosed onto the sample. Ethylene adsorbs only on the existing CO-layer if the whole surface is covered by CO. When instead the surface is already covered with C<sub>2</sub>H<sub>4</sub> the CO molecules can penetrate the Ethylene-layer and take their places.

**References:** M. Hein, P. Dumas, A. Otto G.P. Williams, CO interaction with co-adsorbed C<sub>2</sub>H<sub>4</sub> on Cu(111) as revealed by friction with the conduction electrons. Surface Science, 465, (2000), 249.



**Figure 1.** RAIRS spectra of the CO-stretch mode on Cu(110), which shows shift and broadening after additional Ethylene dosing



**Figure 2.** RAIRS spectra of a 1L Ethylene-covered Cu(110) crystal. Dosing of CO brings up a broad shifted CO-stretch mode, which sharpens as the sample is heated (at 1260 cm<sup>-1</sup> the C<sub>2</sub>H<sub>4</sub> scissor mode is observable)